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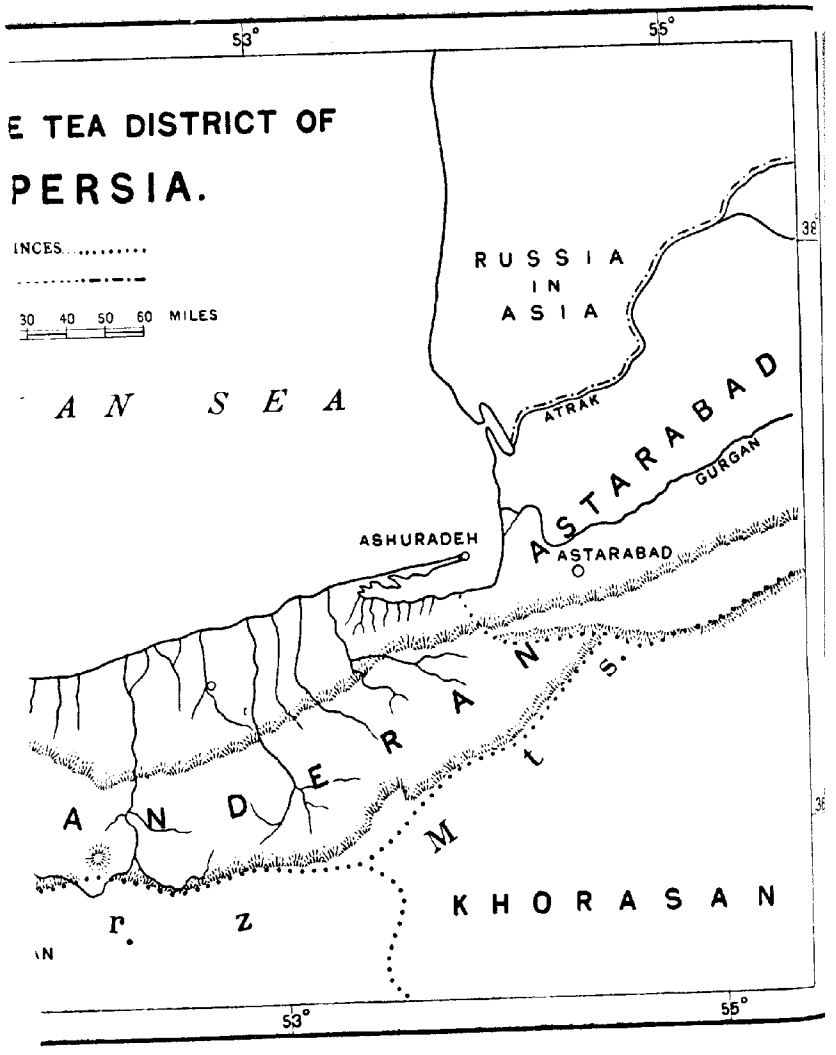
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THE CULTIVATION OF TEA IN THE CASPIAN PROVINCES OF PERSIA

BY

G. D. HOPE B. SC. P.H.D. F.C.S.

In June last during the period of my leave from India, crossing Europe, I travelled as far as Baku on the Caspian Sea—the first stage of a journey made with the object of visiting some of the small tea gardens in Trans-Caucasia. On arrival in Baku I learnt from the British Consul that in addition to a number of tea gardens under Russian management in the neighbourhood of Batoum on the Black Sea there were a few small gardens also in North Persia, near Resht, and these I visited.

These gardens are owned and managed by Persians, and the history of the enterprise is to the effect that some ten years ago a Persian prince, named Kashef-es-Sultaneh brought some tea seed from India, and hired the services of a Persian who had spent several years in India and China, and studied tea in these countries, to instruct the Persian villagers. This man died some years ago n the neighbourhood of Resht.

I cannot vouch for the complete accuracy even of this scanty ccount. It was obtained in conversation in Persian between the British Consul and a friend of the owner of a small tea garden and vas translated into English for my benefit by the former.

The tea gardens in this part of the world are not of any great ommercial importance at present, but what was at once obvious o me was that here, immediately south of the Caspian Sea between t and the Elburz Mountains, which form the northern edge of the great Persian plateau, is a country eminently suited, geographically nd climatically, for tea cultivation, while I believe I am right in aying that in no other part of Persia would this be possible on ccount of the low rainfall. I made therefore as many enquiries as possible relating to the natural features of this tract while I was

there, and I have been at some pains since then to add to the information I obtained. I propose to give a short general account of this part of Persia before describing the conditions under which tea is cultivated and manufactured there.

Persia is chiefly a country of high elevations and the centre of the country consists of a large elevated plateau. The real low-lands of Persia are the tracts near the sea-coast belonging to the forest clad provinces of the Caspian in the north and the shores of the Persian Gulf below Basra and elsewhere in the south. In the north the rocks of the elevated plateau are thrown into folds which form a curve round the southern portion of the Caspian. These are the Elburz Mountains. They are composed of a variety of the older types of rock such as gneiss, granite, crystalline schists, limestone, etc. In these mountains there are also recent volcanoes. The tracts north of these mountains and immediately south of the Caspian into which they drain are not more than twenty to fifty miles wide. That on the south-west of the Caspian widens out to two hundred and fifty miles from the watershed to the Tigris and Euphrates and Lake Van. On the east also the watershed of the Caspian gradually increases in breadth. Three rivers belonging essentially to Persia in reference to the Caspian watershed, are the Sefid Rud or Kizil Uzain on the south-west, and the Gorgan and Atrek at the south-east corner of the Caspian. The Sefid Rud flows into the Caspian fifty-seven miles east of Resht and the distance from where it breaks through the Elburz Mountains to the sea is seventy miles. I crossed this river on my way from Resht to Lahijan where there is a small tea garden. A glance at the accompanying map of this low lying tract of land between the Elburz Mountains and the Caspian will show the above-mentioned rivers and the position of the tea gardens. This tract of land comprises the provinces of (*a*) Astarabad and Gorgan, (*b*) Mazan-deran, and (*c*) Gilan and Talish.

These three provinces have an entirely different climate from that which is typical of Persia proper.

This shows itself in the nature of the agriculture and in the fauna and flora of the tract. They form for example one of

the five special faunal areas into which Persia is divided. In the Caspian provinces Blanford found the fauna on the whole Palaearctic, most of the animals being identical with those of south-east Europe, but some are essentially endemic, and a singular character is given to the fauna by the presence of certain eastern forms unknown in other parts of Persia, such as the tiger, which is found only in the Caspian provinces and is common near Astarabad, and a remarkable deer of the Indo-Malayan group.

In the provinces of Gilan, Mazanderan and Astarabad, from the shores of the Caspian to an altitude of about 3,000 ft., on the northern slopes of the great mountain range which separates those provinces from the rest of Persia, the flora is similar to that described as Mediterranean. Mazanderan, Gilan, and Astarabad are among the most important rice growing districts of Persia and these provinces produce enough to export. The olive is cultivated near Resht and good oranges are cheap in Mazanderan. Since 1875 a kind of tobacco known as *tutun (Nicotiana rustica)* has been grown near Resht and it appears to flourish exceedingly there. Cotton is grown also in the neighbourhood of Resht. Good hemp grows wild in Mazanderan. Castor oil, sesame, and linseed are also grown in Gilan and Mazanderan. Wine in these provinces is made from wild grapes. The timber forests of Gilan and Mazanderan afford valuable boxwood. The exports of timber including boxwood amounts in some years to as much as £50,000. The monopoly is leased to European firms and the exports consist chiefly of box and oak, and also of alder, ash, beech, elm, hornbeam, juniper, maple, walnut, poplar, etc. Timber is also burnt to clean land for rice. The forest of the lower hills of the northern slopes of the Elburz Mountains are similar in general appearance from a distance to the lower ranges of the Naga hills in Assam.

The rainfall of the Caspian watershed greatly exceeds that of inner Persia. At Astarabad and Ashuradeh at the south-east corner of the Caspian it is about fifty per cent. more than anywhere on the Persian plateau proper. At Resht and Lenkoran in the south-west corner (Lenkoran is actually in Russian Trans-Caucasia) it is from four to five times that of the adjoining district across the ridge to the south. At Resht the annual rainfall is recorded as being

about 56″ while at Teheran, across the ridge to the south, about one hundred and fifty miles distant, it is 9·86″, and on the Persian gulf at Jask it is only 3·24″. With the exception of the Caspian watershed and of that of the Urmia basin and possibly part of Khuzistan, north of Mohammerah, the country has probably in no part a yearly rainfall exceeding 13″ or 14″ and throughout the greater part of central and south-east Persia the yearly rainfall probably does not exceed 6″. The following is a table showing rainfall and altitude in several places in the Caspian provinces and in few other parts of Persia.

	Altitude	Rainfall.
*Lenkoran	−60 ft.	46·82 in.
*Resht	−50 „	56·45 „
*Ashuradeh	−80 „	17·17 „
*Astarabad	−40 „	16·28 „
Urmia	6,225 „	21·50 „
Teheran	3,810 „	9·86 „
Bushire	.....	13·26 „
Ispahan	5,370 „	5·44 „

Along the shores of the Caspian, particularly in Gilan and Mazanderan and also along the Persian Gulf from the Shatt-el-arab down to Bundar Abbas the air during the greater part of the year contains much moisture and the dry and wet bulb thermometers sometimes record the same temperature showing that the air is saturated with moisture. At night heavy dews fall. In Gilan and Mazanderan, however, the air contains much moisture up to considerable elevations and as far as from thirty to forty miles from the sea, but along the Persian Gulf, where vegetation is very scanty, places only a few miles away from the coast and not more than twenty to thirty feet above sea level have comparatively dry climates.

During December and January a dry warm wind comes down from the snowy Elburz Mountains to Gilan. This resembles the *föhn* a wind which blows in the Alps, and both are due to a periodic movement of air from one side of a range of mountains to another which sets up on account of inequalities of pressure. The rain falls chiefly during the winter.

* These places are in the tracts bordering on the Caspian Sea.

Statistics of temperature are difficult to obtain. There are occasional frosts but these occur very seldom and the lowest temperature ever recorded was 25° F. Snow falls only rarely. In winter, while the north part of the Caspian may be frozen over the climate of the Persian shore of that sea may be like that of Madeira. There are often morning fogs. The climate for the greatest part of the year is hot, humid, and unhealthy. The air is almost saturated with moisture. There is however a dry spell in the middle of the summer, but this is not of sufficient duration to interefere seriously with the growth of tea though there is a temporary cessation of crop during that period.

The soil of the district between the Elburz Mountains and the sea is in general clayey in character but that on the slightly higher ground inland near the Elburz Mountains consists of rich red loam. On this red bank two if not more small tea-gardens are situated. The three districts where to my knowledge tea is grown are Fumen, Lahijan and Langrud in the province of Gilan. I saw a small garden at Abata near Fumen and another at Lahijan, both of which have red loamy soils. Langrud which is rather nearer the sea, I did not visit, and I do not know the nature of the soil there. The soil of the Fumen and Lahijan gardens appeared to me to be admirably suited for tea. The following are mechanical analyses of samples which I took at the time of my visits.

	The soil from Fumen.		The soil from Lahijan.	
Moisture	1·88%		1·90%	
Organic matter	6·32%		7·24%	
Soluble in acid	1·11%		1·04%	
Coarse sand	2·18%	20·32%	8·06%	19·92%
Fine sand	18.14%		11·86%	
Silt	50·52%	58·08%	45·55%	56·05%
Fine silt	7.56%		10·50%	
Clay	18·61%		21·09%	

The texture of these soils is very different from those of the tea-soils of North East India. A noticeable feature in them is the small amount of fine silt and the large amount of silt. I know of

no instance of a tea soil of North East India containing so high a percentage of silt. The only example of a soil approximating to these in character is one defined by Hall in his book on soils as a light loamy subsoil and having the following composition :—

Sand	29·4	
Silt	40·8	45·15
Fine silt	5·7	
Clay	16·4	

But this latter soil is undoubtedly rather lighter in texture owing to the presence of a larger percentage of coarse sand. No tea soils of North East India which I have analysed in the same way approach at all these soils in character.

From the foregoing it will be clear that the Caspian provinces of Persia possess a climate, situation, and soil well suited to tea. As far as can be judged the district, chiefly on account of a comparatively low temperature, is not one in which the yield would be exceedingly large, but that comparatively cool nights such as occur there do not militate seriously against good crops is indicated by the case of Java and other countries where hot nights such as are experienced in the summer months in India do not occur in the tea growing districts. It is highly probable too that if the tea bushes here were of better type and properly cultivated, pruned, and plucked, they might yield tea of fair quality. A definite cold weather such as is experienced in this tract has a beneficial influence undoubtedly on the quality of tea.

Labour is much more likely to prove the limiting factor in the extention of the tea industry in the district. What little information I was able to gather on the subject is given below in describing the work done on the few gardens which exist at present. These provinces are the wealthiest in Persia, and even the poorest of the inhabitants are comparatively well off and prefer to work on their own land to becoming the servants of others.

I have already stated that the existing gardens are not of any commerical importance at present. The bushes are small, and of poor type, the cultivation scanty, and the methods, if the term can

be used, of plucking and pruning primitive. The following is a description of a garden near Lahijan which I visited and of the kinds of cultivation etc., carried out there. Some of the information was obtained from the owner of this and several other small estates.

The seed is sown in autumn to as late as the middle of of November, and it is left in the nursery until it is two years old, when it is about a quarter of a *zar* high (1 *zar* = 40·95 in.). The seedlings are planted out in spring or autumn. The tea is not plucked until it is four years old from seed but the ground is hoed to remove weeds. After the tea reaches the age of four years it is plucked regularly during the summer months. The leaf plucked in the spring is of better quality than that plucked later in the season. If there is a drought during the summer the bushes stop flushing. The pluckings are at intervals of about ten days. The pruning consists of cutting down the bushes to a suitable height in the autumn by means of clippers. I did not notice any diseases on the plants but I was informed that seedlings had been known to be killed by excessive wet. Hoeing is carried on every ten days and at the same time as plucking. The tools used for cultivation are a *bil*, a kind of hoe and a *japar*, a spade with a bar of iron placed so as to enable the digger to exert pressure by putting his foot on it. The latter is the typical Persian spade.

1 *jereeb* (i. e. 10,000 square zar = about 2·7 acres) is worked by two labourers. In Lahijan there are no gardens larger than five jereebs and all the tea in Lahijan and Langrud does not total more than twenty jereebs.

On the gardens which I saw the arrangement of the planting was square and the distance between the bushes was one zar.

The methods of manufacture likewise are primitive in the extreme. After the leaf is plucked it is left for about fifteen hours before it is manufactured and this permits of a certain amount of withering. It is then hand-rolled and dried in a wooden box resembling a small Sirocco and containing a set of four trays made of wood with mul-mul bottoms. The box is heated from below by means of a charcoal fire and the drying is said to take from one to one and a half hours.

The labour used in these little tea gardens is obtained locally and there are the two systems—free and contract labour. A free labourer is paid about one *quran* (1 quran is about $4\frac{3}{4}$d) a day but during the time of rice cultivation there is the same difficulty about obtaining labour for tea gardens which is not unknown elsewhere. Contract labour consists of villagers who live in the neighbourhood. They are paid a fixed sum of *tomans* annually and also receive rice free. In addition to this nomadic Kurds from Khalkhal between Gilan and Tabriz work in winter. Their pay is one quran a day and six *man shahs* (1 man shah = 13 lbs.) of rice a month. If labour of this type is scarce special inducements are offered in the shape of an increased wage amounting to one and a half qurans a day.

A NOTE ON THE EXPORT OF MANURES FROM INDIA.

Attention is directed to the following statement in which the quantity and value of various kinds of manures exported from India to different countries during the years 1910-11—1911-12 and 1912-13 are put in tabular form.

The figures which are particularly interesting are those of exports to Ceylon, because it can safely be assumed that the greater part of the manures which are imported into Ceylon are used for tea.

The steady increase in the amount of money expended by Ceylon in bringing manures from India is a point worth notice. In 1911-12 the amount of oilcake exported to Ceylon was less than in 1910-11 but the price of oilcake had risen considerably so that the total expenditure on oilcake was higher.

The most serious losses to India from the point of view of the Tea Industry are those of fish manure, fish guano, and oilcakes :—

Statement showing the quantity and value of different kinds of manures exported from India to different countries during 1910-11, 1911-12 and 1912-13.

BONES.

	Quantity—Tons.			Value—in Sterling.		
Exported to	1910-11.	1911-12.	1912-13.	1910-11.	1911-12.	1912-13.
United Kingdom	14,056	13,269	15,454	£ 59,958	£ 62,085	£ 74,843
Ceylon	6,482	8,648	8,781	£ 21,676	£ 32,061	£ 32,739
Straits Settlements (including Labuan)	45	5	81	£ 113	£ 22	£ 423
Hongkong	2,661	758	15	£ 12,312	£ 3,531	£ 85
Natal	825	750	300	£ 3,467	£ 3,750	£ 1,436
Western Australia	30	.....	.....	.....	.....	.....
New Zealand.....	7,310	4,002	3,739	£ 34,127	£ 20,201	£ 19,602
Other British Possessions.....	.....	7	.....	.....	£ 30	.....
Germany	9,952	9,553	13,006	£ 44,526	£ 47,604	£ 65,627
Holland	400	.....	.....	£ 1,785	.....	.....
Belgium	23,262	29,894	33,822	£101,940	£137,803	£159,332
France	13,249	13,419	17,089	£ 57,833	£ 62,289	£ 81,788
Austria Hungary	.....	10	441	.....	£ 33	£ 2,297
Japan	4,659	6,247	9,170	£ 20,533	£ 29,431	£ 46,609
U.S.A. { Atlantic Coast ..... / Pacific Coast	750	400 / 1,400	2,927 / 4,834	£ 3,299	£ 2,000 / £ 6,860	£ 14,171 / £ 24,031
Sandwich Islands	.....	600	550	.....	£ 2,920	£ 2,693
Other foreign countries	1	1	12	£ 5	£ 3	£ 63
Total	83,682	88,963	110,221	£361,694	£410,623	£525,739

FISH MANURES AND GUANO.

Exported to	Quantity—Tons. 1910-11.	1911-12.	1912-13.	Value—in Sterling. 1910-11.	1911-12.	1912-13.
Ceylon	14,161	14,629	17,885	£42,652	£45,290	£53,429
Straits Settlements (including Labuan)	2,192	3,157	3,242	£ 8,967	£12,780	£14,464
Hongkong	92	176	31	£ 434	£ 1,272	£ 187
Zanzibar & Pemba	105	.....	2	£ 700	.....	£ 5
Germany	.....	555	112	.....	£ 2,417	£ 667
Japan	22	106	136	£ 115	£ 391	£ 662
German East Africa	37	.....	.....	£ 250	.....	.....
Total	16,609	18,623	21,408	£53,118	£62,150	£69,414

OTHER KINDS.

Exported to	Quantity—Tons. 1910-11.	1911-12.	1912-13.	Value—in Sterling. 1910-11.	1911-12.	1912-13.
United Kingdom	369	404	1,370	£ 2,500	£ 2,810	£ 6,922
Aden & Dependencies	5	49	26	£ 35	£ 120	£ 208
Ceylon	902	682	2,543	£ 5,352	£ 5,241	£11,994
Straits Settlements (including Labuan)	419	344	17	£ 3,590	£ 2,388	£ 172
Other British Possessions	.....	.....	27	.....	.....	£ 52
Germany	950	895	916	£ 5,384	£ 4,996	£ 4,439
France	.....	18	140	.....	£ 99	£ 887
Austria-Hungary	.....	26	188	.....	£ 170	£ 756
Native States in Arabia other than Maskat-Territory & Trucial Oman	1	13	11	£ 4	£ 115	£ 94
Japan	224	305	586	£ 1,956	£ 1,204	£ 2,972
U. S. A. { Atlantic Coast.....	967	1,373	2,500	£ 8,106	£11,353	£22,303
U. S. A. { Pacific Coast		191	.....		£ 1,780	.....
Other foreign countries	15	6	14	£ 73	£ 53	£ 91
Total	3,852	4,306	8,338	£27,000	£30,629	£50,890

OIL CAKES (*all kinds.*)

Exported to	Quantity—Tons. 1910-11.	1911-12.	1912-13.	Value—in Sterling. 1910-11.	1911-12.	1912-13.
United Kingdom	627,585	740.187	933.805	£149,650	£177.957	£226,898
Ceylon	944,688	856.685	964.723	£243.157	£250,285	£292,826
Straits Settlements (including Labuan)	64.670	35,955	46,241	£ 15,021	£ 8,138	£ 11,648
Hongkong	20,602	13.336	41	£ 3,916	£ 2,243	£ 8
Mauritius & Dependencies	100	.....	.....	£ 29	.....	.....
Other British Possessions	100	371	258	£ 36	£ 73	£ 53
Germany	293,420	548,914	501,563	£ 77,539	£140,381	£130.381
Holland	.....	2,001	9.823	.....	£ 642	£ 3,542
Belgium	2,000	5,608	.....	£ 400	£ 1,058	.....
France	2,380	2,995	.....	£ 678	£ 840	.....
Java	25,800	8,820	20,692	£ 6,820	£ 1,984	£ 5 457
Indo-China (including Cochin China, Cambodia Annam & Tonkin)	15,900	23.440	12,603	£ 3,737	£ 4,918	£ 2,533
China (Exclusive of Hongkong & Macao)	.....	24.258	9,155	.....	£ 3,842	£ 1,583
Japan	297 576	502,468	736,786	£ 58.606	£ 98,559	£146,453
Other foreign countries	35	.....	13	£ 8	.....	£ 5
Total	2,294,856	2,761,438	3,235,703	£559,594	£690,920	£821,387

TOTAL (*all manures.*)

	Quantity—Tons. 1910-11.	1911-12	1912-13.	Value—in Sterling. 1910-11.	1911-12.	1912-13.
Animal Bones	83,682	88,963	110,221	£361,694	£410,623	£525,739
Fish Manure	16,421	18,356	21,408	£ 52.208	£ 60,959	£ 69,414
Guano	188	267		£ 910	£ 1,191	
*Oilcake (all kinds including manures)	55.516	59.799	3,235,703	£244,319	£270,989	£821,387
Other kinds	3,852	4.306	8.338	£ 27,000	£ 30,629	£ 50,890
Total	159,659	171.691	3,375,670	£686,131	£774,391	£1.467,430

*The figures for 1910-11 and 1911-12 represent exports of "Oilcake (Manure)" while those for 1912-13 represent "Oilcake (All kinds including Manures)."

FUNGI PARASITIC ON THE TEA PLANT IN NORTH EAST INDIA

BY

A. C. TUNSTALL, B. SC.

Part III.

ASCOMYCETES (*continued.*)

Nectria.—A genus containing many members parasitic on trees, causing on some the swellings known as *cankers*.

The canker of the tea plant appears to be associated with one or more species of the genus but up to the present it has not been conclusively proved that the swellings are caused by this fungus, which may possibly be only secondary. *Nectrias* are wound parasites. This means that as a rule they attack plants at cuts or abrasions. It is extremely probable that the fungus generally attacks tea bushes through the cavities left by rotting snags which have not been pruned off properly. Abrasions caused by hail and twigs torn by cattle are often infected. The bark around the wound is first attacked and afterwards the wood is destroyed. The unaffected bark often forms a callus over the wound thus giving the characteristic lumpy appearance to the diseased twigs. After a short time small pink cushions, measuring usually a sixteenth to an eighth of an inch in diameter, appear on the bark of the diseased places. These bear the conidial form of spore on their surface. Months later, generally after the death of the bush, clusters of deep red spheres are formed. These are the perithecia in which the ascospores are produced.

It should be pointed out here that other fungi, mostly harmless, produce fruit bodies very similar to those of *Nectria* and planters will find difficulty in distinguishing these from true *Nectria*. One fungus which is frequently confused with *Nectria* is a species of *Aschersonia* which feeds on scale insects. The pink cushion shaped fruit bodies of this fungus are to be found on tea leaves

and shoots on most gardens throughout the cold weather. The fructifications peel off easily and the mycelium does not appear to enter the tissues of the plant. It is significant that *Nectria* is frequently found on tea plants bearing canker swellings and is not usually observed on plants free from these. For definite proof it is necessary to produce in healthy plants the characteristic symptoms of the diseased by innoculation with spores or mycelium of the fungus. It is necessary that the spores be unmixed with those of any other fungi as one of the latter may be the cause of the symptoms produced. To ensure this the fungus under observation is grown in what is technically known as pure culture. As a result of investigations extending over long periods the chemical mixtures most suitable for the growth of particular fungi have been discovered. These solutions are generally solidified by the addition of gelatine or agar. The solutions (media) are boiled and then allowed to solidify in sterilised glass vessels.

Spores of the fungus required in pure culture are then sown on the media. In a few hours or days as the case may be fungal growth may have commenced. If the medium is unsuitable the spores either refuse to germinate or the resulting growth dies before sporulating. In this case the chemical constituents of the medium have to be varied until a suitable mixture has been obtained. When growth is satisfactory each germinated spore produces a spot of mycelium which continues to increase in size. At the time of sowing it is possible that spores of other fungi were introduced and in many cases it is impossible at this stage to differentiate the mycelium of these from that of the fungus required. It is necessary therefore to transplant the individual spots to separate vessels.

Although the fungus may grow well on a medium it may not produce spores. In this case other media must be tried until one is obtained which gives the desired results. In the case of tea a *Nectria* the most satisfactory growth was obtained on pith impregnated with a solution containing tea juice. Although pure cultures of the fungus have been obtained in our laboratory so far only one kind of spores has been produced. These spores have not given successful inoculations on tea up to the present.

The fungus causing tea canker travels downwards towards the root. Its mycelium may generally be found in the wood of an infected shoot considerably below the point at which the effects of the fungus are made obvious by the death of buds and the production of pink fruit bodies. In dealing with this disease it is therefore necessary to cut out not only all the dead twigs but also living wood three or four inches below the dead portion on their twigs and even lower on thicker ones. In the case of a badly infected bush it is best to collar prune. Needless to say the prunings should be carefully destroyed.

In places where the disease is serious general spraying with Bordeaux mixture immediately after pruning and burning of all prunings from the areas most badly effected would retard the disease.

Canker appears to be causing most damage to tea on deteriorated bheels. The fungus associated with this canker had been identified as *Nectria cancri*, (Rutgers.)

The canker of Sau trees apparently is not caused by a *Nectria* but by other fungi which will be considered later.

ORGANIC MATTER IN SOILS.

It is well known that soils differ from one another not only in origin, but also in chemical composition, physical texture, and fertility. One soil supports a luxuriant vegetation whereas on another the growth of jungle is scanty, or the species of plants formed on one soil differ entirely from those growing on another. Such differences can be noted on soils in the same neighbourhood and even on soils that seem to be very similar when judged merely by eye.

This leads to enquiry as to the reasons for these differences. They may be due to several causes such as lack of the necessary plant food substances in one soil and abundance in another, adequate drainage in one and conditions leading to water logging in the other. Differences in the amount of lime in soils is perhaps one of the most common causes of appearance or absence of certain species of plants on a soil. The cause however is often due to the nature and amount of the organic matter in soils and lack of it particularly in tropical and subtropical areas subjected to heavy rainfall is a common cause of poor physical condition and infertility of soils. Soils under cultivation often exhibit defects from this cause and in almost every tea district in North East India that has been under cultivation for a number of years, numbers of instances are to be seen where differences in the fertility of the soils are accounted for by varying amounts of organic matter present, and cases of infertility can be attributed to lack of it. This is often evident when in other respects the chemical and mechanical composition of soils are apparently similar. A peat bheel soil will often produce twenty-five maunds of tea per acre whereas the yield from the average good plateau soils is not nearly so high being perhaps at the outside about fourteen maunds per acre. There are many differences in the two classes of soil but the most noticeable feature is the difference in the quantity of organic matter present. Both classes of soil have usually an ample supply of nitrogen, potash, and phosphoric acid, and yet often differ very widely in regard to

fertility. It has also been observed that land that has been cultivated for a number of years but has received no other treatment is not capable of producing a large harvest indefinitely. Analyses of the soil in such cases often indicate that there is still present an abundant supply of all these chemical substances which are required by the plant for growth but also show that a considerable diminution has taken place in the amount of organic matter present in the soil. The quantity and condition of the organic matter in a soil are very great factors in determining the state of fertility of that soil and account for final loss in fertility in such cases, and it is therefore of interest to consider a little more carefully what is the use of organic matter in a soil and how it can be added to one in which it is already deficient and maintained in a soil that has a sufficiency. This leads at once to the enquiry what is organic matter, and in what form is it directly suitable for influencing the fertility of a soil by improving or maintaining its chemical and physical condition.

Organic matter in soils is derived from two sources, animal and vegetable, the latter being by far the more general. It is obtained usually by plant refuse becoming incorporated in the soil. It however does not, on a well drained soil, remain in its original state but rapidly undergoes decomposition chiefly through the agency of soil fungi and bacteria, and looses its organised structure and becomes converted into a dark brown substance which is a complex mixture of chemical compounds containing carbon, hydrogen, oxygen, nitrogen, phosphorus, sulphur, etc. Some of these compounds are soluble and some insoluble in soil water. The particular fungi and bacteria which are present in the soil determine very largely the value of the decomposition products which are formed and on the actual species of fungi and bacteria which are present in a soil depends very much its physical condition. This brown decomposition complex is known as humus, and it is this which plays so important a part in determining the general character and fertility or otherwise of a soil. Under some conditions a greater quantity of certain substances such as acids will be formed than under others, and it is desirable that the manner of decomposition shall to some extent be controlled and that a humus

shall be formed which will be beneficial to the soil. Also it is desirable that the formation of soluble substances shall not be too rapid for otherwise the soil will quickly become depleted of humus. Humus that is formed under insufficient drainage conditions is often acid, as in the case of peat. Humus, although a decomposition product, is not the final stage to which decomposition can proceed. By the further action of fungi and bacteria it can in turn be decomposed into simpler substances which have a greater tendency to be soluble in water, The final products of decomposition are carbon dioxide and water.

Having now discussed the changes that organic matter undergoes in the soil it remains to consider what effects such changes produce in the condition of the soil. Perhaps one of the most important effects is the change that takes place in the physical condition of the soil, and this is brought about chiefly through the action of the humus present and much less by the undecomposed organic matter or only partially formed humus. Humus and organic matter when decomposing in the soil produce a certain quantity of gases the chief of which is carbon dioxide and this tends to separate the soil particles and to produce a condition of the soil which makes it more easy of tillage, and allows of better aeration and the freer movement of water. It has already been stated that during the decomposition processes acids are formed, and these have considerable influence upon the soil particles. The small particles are flocculated to form larger particles composed of several smaller ones, thus also increasing the interparticle space. Such flocculating action is of particular importance in soils containing large quantities of clay or fine silt. In sandy soil the action of the acids upon the particles will be to form a binding material which will aid in the retention of plant food material. Humus and organic matter retain large quantities of water and in the dry weather a soil rich in humus will be found to contain much larger quantities of water than a soil deficient in this substance. Such retention of water is of the greatest importance in districts liable to prolonged drought, but even in districts that do not actually suffer from drought it has an effect in that the soil is kept constantly damp and bacterial activity is favoured thereby.

Soils consisting largely of very coarse and very fine particles are liable under cultivation to form a pan just below the cultivation depth by the gradual subsidence of the finer particles. Humus by flocculating the finer particles prevents the formation of such pans. In other soils again a pan is sometimes formed by the removal from the surface layers in solution of the iron oxide and alumina which is deposited in an insoluble form again at a lower depth thus forming a pan by precipitation. Such pans are impervious to water and are of a particularly objectional nature. These are also prevented from forming by the presence of the acids present in humus and also by the solvent action of an aqueous solution of carbon dioxide gas.

The employment of any particular form of manure should be dependant upon the physical condition of the soil, and also upon the percentage of humus present. In soil deficient in humus for instance readily available sources of phosphoric acid such as superphosphates or guanos are found to be most beneficial whereas such insoluble manures as crushed bones and powdered mineral phosphates have been found to give good results on soils rich in humus. By the decomposition of humus carbon dioxide gas is formed and it is the solution of this in the soil water that has so large a bearing on the question of solubility of phosphates. Potash is capable of uniting directly with the acids formed by the decomposition of the organic matter and humus to form but slightly soluble bodies which are retained in the soil and loss of potash is thereby reduced. Without the presence of humus and decaying organic matter the formation of nitrates from other nitrogenous bodies is checked and in some cases may be altogether inhibited. When such conditions obtain little or no benefit is derived from the use of insoluble nitrogenous compounds such as oil cake, sterilised animal meal, etc. Only those manures which are soluble and directly available as plant food are then of value. The stage when nitrification has ceased owing to absence of humus in the soil has not yet been reached in the soils of the tea districts of North East India but in some soils nitrification is undoubtedly slow owing to the small amount of organic matter which they contain. In countries where there is a heavy rainfall the use of soluble manures such

as nitrates has disadvantages owing to the comparatively large percentage of the manure that is removed in solution by water draining through the soil, and for this reason it is preferable to employ manures which become converted into soluble bodies only slowly.

In the tea districts of North East India there had existed for some time a prejudice against the use of inorganic or as they are more commonly termed chemical manures, and this prejudice is not without some justification. In countries where agriculturists have had a large experience of the value of different manures a higher relative price is paid for manures containing organic matter such as oil cakes, etc., then for purely inorganic manures such as nitrate of soda when both manures are used to supply nitrogen because it has been noticed that arable land, to which only inorganic manures are added, slowly looses its tilth and becomes less fertile whereas those soils which have received the manure in an organic form suffer no such deterioration. This can easily be explained. Inorganic manures add no organic matter to the soil and constant cultivation depletes the soil of what originally existed there. The soil in consequence gradually becomes poorer and poorer in humus, particularly if the crop which is grown in it is removed in harvesting, until a time is reached when the fertility of the soil is affected. On the other hand the employment of organic manures adds organic matter even if in only small quantities and this on decomposition replaces, at any rate in part, the humus that is lost through cultivation. It is therefore necessary to supply organic matter in some form if inorganic manures are being used. *If this be done the humus content of the soil will not suffer* depletion and inorganic manures can be employed for any number of years, if suitably chosen, without any deleterious effect on the soil. In tropical and subtropical countries subjected to a heavy rainfall and a high temperature the decomposition of humus is very rapid and the addition of small quantities of organic manures such as five maunds per acre of oil cake will not be sufficient to maintain the necessary quantity of humus although some of the value of such applications is undoubtedly due to the organic matter they supply. The further addition of organic matter will in any case be necessary.

Cattle manure and lime manure are both possible sources of organic matter but the quantity that is available for application allows of but very small areas being treated with an adequate quantity. The cost of transport is also considerable. They should however be employed wherever possible. Another source of organic matter is top dressing and this is of particular value since it is already partially decomposed organic matter and has been converted into humus. The use of this material will for this reason frequently give results more rapidly than the above mentioned forms of organic manures. There is however always the possibility of top dressing material being of an acid nature and precaution should be taken by addition to the soil of lime, preferably as crushed limestone, to neutralise the acids that may be present in the top dressing. A word of caution must be said in this connection. It is essential that the top-dressing employed should contain a high percentage of organic matter or humus. Much of the top dressing that has and is still used in tea gardens is quite unsuited for this purpose since it contains but a small quantity of organic material and often a high percentage of clay. Such top dressing will tend to make the soil to which it is added heavy and if the soil is already stiff the last state of the soil will be worse than the first. The same amount of harm cannot be done in this manner to a light sandy soil and the texture of the soil may be even improved, but the addition of organic matter has still not been accomplished by the application. Except in case of actual peat a casual inspection of the top dressing material is of no use in determining its value and may lead to erroneous conclusions. The top dressing material may have a dark appearance and lead to the supposition that it is a material of considerable value but analysis may show that it is by no means so rich in organic matter as its appearance would indicate. Such instances are by no means uncommon and in view of the impossibility of judging the value of a top dressing soil from mere inspection it is strongly recommended that an analysis of the substance be obtained before it is used.

In the majority of gardens the above mentioned means of supplying organic substances to a soil are of but little importance and dependance must be placed upon the hoeing in of green

crops or of the leaves, etc., that fall from shade trees and the bushes themselves. On many gardens in Ceylon these are the only means whereby organic matter is added to the soil, for the use of artificial manures and the practice of clean weeding are generally prevalent. The soils however of these gardens are usually of a more clayey character than ours and what organic matter is added is not so quickly removed by decomposition. The importance of the growing of green crops cannot be too strongly urged. Most gardens grow far too inadequate an amount, and the reason usually given for this is that it requires a large amount of labour to hoe in green crops at a time when the labour is needed for other purposes. It is customary to grow green crops in the spring and to hoe them in the early summer but this is not essential. They can be successfully grown at other times of the year and advantage should be taken of this. Also it is usual to hoe the crop in deeply and this is the best method to adopt but it is not essential, and it is preferable to grow green crops over a large area of tea and to turn it in lightly, or even to sickle it rather than to treat only a small area and to hoe it in deeply. By the former method a little loss is incurred but the advantage of the addition of organic matter to a soil outweighs the slight loss. If at the time of burying the green crop it be but lightly turned in, it may not be entirely buried but the following light hoe will complete the work.

It is not necessary to enter into a discussion of soil acidity in this article save to point out that such acidity as may be formed is the result of decomposition of the organic matter and humus under unfavourable soil conditions. The neutralisation of this acidity is dependent upon the presence of carbonates chiefly those of lime and magnesia and in many soils of the tea districts the quantity of lime is very low and in very few cases is the total amount of the carbonates of these two substances appreciable. It would therefore be expected that the majority of soils would be found to be acid and this has proved to be the case in many of the soils which have been studied. The continued use of manures containing organic matter such as oilcake, sterilised animal meal, fish guano, etc., has in some cases accentuated the acidity. We possess however a remedy for this is applying lime in one or another form to the soil.

Absence of humus in a soil restricts bacterial action. On the other hand the particular organic substances present in the soil and the particular physical conditions existing therein materially affect the development of the various kinds of soil bacteria. Under certain conditions the decomposition of organic substances will result in the formation of excessive quantities of acids and although these may not directly affect the growth and health of the tea plant yet they may directly influence the development of desirable soil bacteria.

A plant obtains its nitrogen in the form of nitrates and these are produced as a decomposition product resulting from the action of certain bacteria on complex and insoluble nitrogen compounds which are found in animal and vegetable refuse. The development of such bacteria plays a part in the production of nitrates from organic matter and is restricted by acids, and in the presence of large quantities the production of nitrates will cease. There is however another serious effect of acidity in a soil and that is that it favours the activity of bacteria which destroy the nitrates and convert them again into insoluble nitrogenous compounds. In an acid soil then not only is the formation of nitrates prevented but those that already exist are destroyed and the soil becomes depleted of available nitrates. Plants can no longer obtain a supply of nitrogen and they become starved and growth ceases.

A plant when growing requires for its development and nourishment carbon, hydrogen, oxygen, nitrogen, potash and phosphorus, and other substances in smaller quantities. The organic carbon compounds in the humus of the soil although, as we have seen, they contain the same chemical elements as we found in plants do not act directly as food to a plant and even on decomposition only supply certain of these elements. Carbon is taken in by plants entirely through its leaves in the form of carbon dioxide gas and not in the form of organic compounds supplied by the humus of the soil. The humus also acts as a source of food to soil bacteria with the result that substances available to plants are formed in the soil as decomposition proceeds.

Finally a note may be added with regard to the relationship between the amount of humus in the soil and the prevalence or

otherwise of white ants. White ants do not live in sand, nor in bheels. They will flourish in a soil with practically no organic matter, or in a soil with much organic matter. They flourish in well drained clayey flats such as those of Cachar, and do much damage there. They prefer a well drained place if possible. In sand it is impossible for them to build. In a bheel it would be difficult to build. Probably ants like a certain amount of organic matter. They must have it to grow the fungi which they use as food. Excess of organic matter would produce conditions unfavourable for the fungi. Also, excess of organic matter means excessive retention of moisture, which would be unfavourable to white ants.

It is hardly likely that addition of organic matter to a soil poor in organic matter will prevent attacks of white ants, nor is it probable that in soils with normal amounts of organic matter, the amount present affects the question greatly. An excessive quantity of organic matter such as is found in a bheel soil is likely to prevent attacks of white ants.

The presence of the organic matter and humus in a soil is then of great practical importance in maintaining its fertility.

To summarize what we have said :—

1. Humus affects the physical condition of the soil by flocculating the finer particles such as clay and by cementing the coarser particles in a coarse sand. It may be of practical assistance to tea planters to have rough figures for the percentage of organic matter which it is desirable to have in soil of certain textures. Fine textured soils, i. e. such as contain over 50% of silt, fine silt, and clay, should contain say, 10% of organic matter. Coarser textured soils i. e. those containing over 50% of coarse and fine sand, require not less than 5% of organic matter. These numbers do not represent the maximum or optimum quantities but are given merely to act as a rough guide to enable those in charge of gardens to determine whether it is necessary or otherwise to add organic matter to the soil.

2. Humus tends to prevent a soil becoming panned.
3. Humus retains water and tends to prevent a soil from becoming unduly dry during a prolonged drought.
4. Humus aids in the retention by a soil of soluble plant food materials.
5. Humus accelerates the decomposition of insoluble mineral substances in the soil.
6. If a soil contains a sufficiency of humus the use of the most economical types of artificial manures is permissible.
7. There is a relationship between the amount of humus in a soil and the prevalence or otherwise of white ants.

RECENT TOURS.

Chief Scientific Officer.

At the beginning of February, the Chief Scientific Officer visited the Dooars with the object of examining a case of deteriorated tea on a garden in the Chulsa district. Several of the gardens in this district are on the Red Bank but the tea garden in question was on a totally different soil which belongs to a type described by Dr. Mann as the grey sandy loam of the Dooars. Soils of this type which are transported and not sedentary soils, are of comparatively recent formation. They are light grey to nearly black in colour, and loose in texture, and easily drained, and a feature of their chemical composition is the high percentage of magnesia which they contain. The last feature may account for the unsuitability of certain patches of this soil for tea culture, but it is more than probable that suitable manurial treatment will remedy this defect.

While he was in the Dooars he also took the opportunity of visiting the Chairman of the Dooars Planters' Association. On the 8th of February, he left Calcutta for Cachar and visited two gardens in the Cherra district where he made recommendations for manuring. It was noted that white ants do considerable damage to the bushes both on the tilas and flats of Cachar gardens. Forking round the collars of bushes which have been, or are likely to be attacked by white ants is not perhaps a complete remedy but it is a very useful and practical preventive measure. This treatment combined with good and careful pruning (and pruning it may be mentioned has not reached the level of excellence in this district which has now been attained in Assam) and heavy manuring should make the bushes in every way more vigorous and healthy, and reduce the likelihood of damage from white-ants. The tilas of the Cherra gardens would undoubtedly benefit considerably from addition of organic matter by growth of green crops and green crops would grow more vigorously if they were used in conjunction with appli-

cations of artificial manures. Particular recommendations based on this principle were made by the Chief Scientific Officer. On the 13th February, the Chief Scientific Officer arrived at Tocklai and stayed there until the 22nd. While he was there he visited one or two neighbouring gardens to see the pruning done there. On the 23rd he left for Calcutta and on the 26th he proceeded to Darjeeling and on the 28th he gave an address at the Annual General Meeting of the Darjeeling Planters' Association. The subject of this address was chiefly a description of certain observations applicable to Darjeeling conditions made during his recent tours in Java and Ceylon. He impressed on Darjeeling planters the excellent results which have been obtained in Java from careful terracing of slopes combined with a system of catch trenches and suitable drainage and recorded the good results which were generally obtained in Ceylon from the extensive use of manures. The tea in Java and Ceylon is undoubtedly in a more healthy condition and very much freer from pests and blights than most of the tea in the Darjeeling district. The first step to be taken in dealing with the pests and blights of the Darjeeling districts is to invigorate bushes by every means available. In manuring with artificials a practical means is available of adding materially to the general health and vigour of bushes in the Darjeeling tea gardens, without affecting the quality of the tea to a degree which would counterbalance the benefits obtained in other directions.

The Chief Scientific Officer toured in the beginning of May in the Jainti sub-district of the Dooars. The soils of the gardens to the east of Rydak river are peculiar in character and present special problems. Their leading characteristic is the presence of a coarse sandy sub-soil, which is often replaced by gravel, underlying at a considerable depth a stiff surface soil which in places is of a very intractable character. Under such conditions, with the high rainfall which obtains in this district, efficient drainage is only obtained if levels are carefully studied and full use made of all natural facilities for leading away water, and drains for this purpose must be fairly deep and close together. Although some of these soils retain water so persistently the remedy lies not entirely in the drainage system but also in dealing with the soils in cultivation and

manuring in such a way as to improve the tilth and increase their porosity. The growth of green manures undoubtedly tends in the right direction but cultivation must be carried out very carefully if it is to have good results and hoeing during wet weather should be carefully avoided. The effect of lime on such soils has not been sufficiently experimented with and it is very probable that fairly heavy dressings would gradually improve the tilth of such soils. On the heaviest soils of these gardens an experiment with tiled drains would be very interesting and as an alternative a trial might be made during the cold weather of explosives to loosen the subsoil. In connection with the use of green manures it is interesting to note that most of those used on these tea gardens grow well. An exception apparently being Soya beans which however grow well on gravel soils in the neighbourhood.

On one of the gardens of this neighbourhood it was noticed that the soil which had been removed from round the collars of bushes in forking during the cold weather had not been replaced. On such heavy soils as are found in this district it is advisable to take precautions to prevent depressions round bushes as the result of thullying remaining so late that there is the possibility of rain collecting in them. On heavy soils the water collects in such holes by the puddling of the clay and it is more than probable that damage may be done to the bushes by it, particularly if new shoots are springing up from round the collars as is the case if the bushes have been collar or heavy pruned. Admirable as is the work of forking round bushes it should be confined to the cold weather if there is any chance, owing to the stiffness of the soil, of pools of water collecting round the bushes during the rains. On lighter soils this danger does not exist and thullying round bushes at any time of the year may be done with advantage.

Assistant Scientific Officer.

The Assistant Scientific Officer toured during the early part of the year in upper and middle Assam, and Sylhet. These tours were made in order to meet various managers and to assist them in formulating their manuring programmes, whilst at the same time the results of the past year's treatment were observed.

In the gardens in Assam a noticeable feature was the endeavour to induce the bushes to produce better wood. In this connection a successful experiment was seen in the removal of a hide bound condition of bushes by the use of a two per cent. caustic soda solution. As a result of the treatment the bushes were seen to be sprouting vigorously from all parts of the wood.

A matter that calls for attention more or less generally throughout the districts visited is the cutting of main canal drains of a proper size. It often appears that the main drain is cut without any consideration being given to—

(1) drains connecting with it,
(2) the quantity of water to be removed, and
(3) the area to be drained,

all of which should influence decision as to the depth and width of the main drain. The volume of water to be carried and the maximum height to which it may be allowed to rise in the main drain often seem to be matters that receive but little consideration. A moment's thought however makes it quite obvious that in order to remove the water carefully from the feeder drains the height of the water in the main drain must not be allowed to rise above the bottom level of the feeder drain. In gardens that possess but a little fall this will necessitate that the main drains shall be made with a wide bottom in order that no great depth of water shall be in them. The width of a drain at the top has but little to do with the problem of drainage except in so far as this is necessitated from the nature of the soil and the way it holds up and the width required at the bottom.

It was noticed in certain gardens in Sylhet, the soils of which possess a high lime content, that the tea growing was of healthy appearance and in no way detrimentally affected by the large quantity of lime in the soil. This is of considerable interest in view of the very general use now-a-days of lime as a manure.

Mycologist.

At the end of April the Mycologist visited Bishnath where he discussed with managers a combined scheme for the monthly notification of the fungal blights in the district.

NOTES.

Boga Medeloa—*(Tephrosia candida)*:—The following figures were obtained from an analysis of a sample of *Tephrosia candida* (Boga medeloa) which was grown at Tocklai Experimental station during the rains of 1913.

LEAVES.

	Calculated on the dried plant.	Calculated on the fresh plant.
Organic matter ...	87·34%	20·44%
Nitrogen	3·85%	0·90%
Lime (CaO) ...	1·80%	0·42%
Magnesia (MgO) ...	0·47%	0·11%
Potash (K_2O) ...	1·39%	0·32%
Phosphoric Acid (P_2O_5)	0·89%	0·21%
Water	...	76·60%

STEMS.

	Calculated on the dried plant.	Calculated on the fresh plant.
Organic matter ...	96·17%	39·91%
Nitrogen	0·79%	0·33%
Lime (CaO) ...	0·62%	0·26%
Magnesia (MgO) ...	0·20%	0·08%
Potash (K_2O) ...	0·80%	0·33%
Phosphoric Acid (P_2O_5)	0·32%	0·13%
Water	...	58·50%

ROOTS.

	Calculated on the dried plant.	Calculated on the fresh plant.
Organic matter ...	95·78%	36·84%
Nitrogen	0.79%	0·33%
Lime (CaO) ...	0·37%	0·15%
Magnesia (MgO) ...	0·17%	0·07%
Potash (K_2O) ...	0·59%	0·25%
Phosphoric Acid (P_2O_5)	0·23%	0·10%
Water	...	58·30%

	ENTIRE PLANT.	
	Dry.	Fresh.
Organic matter ...	93·33%	32·76%
Nitrogen	2·05%	0·72%
Lime (CaO) ...	0·85%	0·30%
Magnesia (MgO) ...	0·28%	0·10%
Potash (K_2O) ...	0·88%	0·31%
Phosphoric Acid (P_2O_5)	·045%	0·16%
Water	...	64·90%

The plant consisted of :—

Leaves...	...	35·72%
Stems ...	...	57·14%
Roots ...	...	7·14%

The growth was luxuriant and a crop, weighing when fresh 12 tons per acre, was obtained.

This contained 9138 lbs. or approximately 4 tons of organic matter. This is equal to approximately 26·5 tons of cattle manure containing 15% organic matter, which is an average percentage for cattle manure in which the urine has not been retained. The above figures can be compared with those obtained from an analysis of Dhaincha (*Sesbania cannabina*) published in ibid part II. 1913.

Some Ceylon Tea Pests :—We here reprint summaries of articles by Mr. Rutherford on The Red Borer and Mites affecting tea in Ceylon, from the Review of Applied Entomology for March, 1914.

Rutherford (A). *Zeuzera coffeae* (Red Borer ; Coffee Borer).—Trop. Agric., Peradeniya, xli, No. 6, December 1913, pp. 486-488.

This insect is widely distributed in Ceylon as a pest of tea. Its presence is indicated by the withering of the leaves and by castings ejected by the caterpillar from its burrow. These castings are oval-cylindrical in shape and yellowish or crimson in colour. If one of the attacked branches is cut open, a tunnel, widening out at irregular intervals, will be found running along its centre. These wider portions are of the nature of lateral galleries that may reach almost to the outside. The width of the tunnel

depends on the age of the caterpillar and the galleries of the young larva are usually straight. The galleries may be so extensive as to girdle the stem ; they may also go down into the roots. When full-grown the larva cuts a circular trapdoor for the exit of the moth. A variety of insects has been found in the tunnels and in some cases they have been mistaken for the real culprit.

The *Zeuzera* has been found feeding on the following plants in Ceylon :—Tea, coffee, loquat, cotton, avocado pear, china apple, orange, *Grevillea*, teak, *Cassia auriculata*, cinnamon and *Erythroxylon*. In India it is recorded from tea, coffee, sandal, and cotton. Being a general feeder it is difficult to deal with. Affected branches should be cut down until untunnelled wood is reached and the larva or pupa in the tunnel killed. Sometimes, as when the tunnel goes below the ground or into the body of the bush, this is not possible. In such a case the pruning should be carried as low down as possible, and the tenant of the gallery killed by prodding with a sharp wire or by putting into the gallery a piece of cotton wool saturated with carbon bisulphide and closing the hole with clay.

Rutherford (A). Mites.—Trop. Agric., Peradeniya, xli, No. 6, December 1913, pp. 490-494.

Dry, finely-divided sulphur has been regarded as a specific against mites, but recent work in the United States shows that is not so in all cases. Dealing with the red spider (*Tetranychus bimaculatus*, Harvey) it was found that "sulphur is effective only when the infested surfaces of the plant are exposed to direct sunshine at some time during the day, or to intense reflected heat." In Ceylon, where sulphur gives good results, one or other of these conditions is usually satisfied. Dry sulphur should be applied when the leaves are wet with dew, or, failing this, they should receive a preliminary spraying with water ; preferably there should be no wind at the time of application. In Ceylon the cost of applying sulphur at the rate of 10 lbs. per acre, proceeded by a spraying with water, has been found to be about 2s. 4d. per acre. Sulphur is now applied in California along with hydrated lime (which may be prepared by adding 32 lbs. of water to 100 lbs.

of quicklime) as the latter causes the sulphur to adhere to the leaves, and also acts as a carrier. The nozzle should throw a washing, rather than a misty, spray. The pressure must not be less than 120 lbs. and angle-nozzles or bent rods are necessary in the case of mites infesting the under surface of leaves. The Yellow Tea Mite (*Tarsonemus translucens*, Green) is probably the most common and most injurious of the mites affecting tea in Ceylon. It is most abundant on the underside of the leaves, where the small whitish eggs and the mites can be seen even with the unaided eye. The mite occurs chiefly on the two or three leaves nearest to the unopened buds, but also on the latter, on the young stem, and, sparingly, on leaves below the two or three that are most heavily infested. Green records this mite as badly attacking *Cosmos sulphurea*, a composite, and the author has seen the same, or a very closely allied mite in injurious numbers on leaves and young stems of a small solanaceous climber (*Solanum venustum*). The leaves become bronzed and withered and frequently drop off. This plant was exposed to the full rays of the afternoon sun.

Mites of this group are usually vegetable feeders and many are of great economic importance. *Tarsonemus oryzae*, Targ.-Toz., causes a disease of rice known as "bleaching" in Italy. *T. spirifex*, March., produces distortion in the panicle of oats in France and Germany. *T. waitei*, Banks., is associated with a peach-bud disease in the United States. *T. bancrofti*, Mich., injures sugar-cane in Barbados* and is present on sugar-cane in Queensland. *T. ananas*, Tryon., is the forerunner of a disease of pine-apples known as "fruitlet core rot" in Queensland. *T. culmicolus*, Reuter, causes a disease of grasses in Finland. *T. latus*, Bks., was found injuring mango plants in Washington. *T. approximatus*, Bks. MS., and *T. assimilis*, Bks. MS., have been taken on *Citrus* in California. *T. buxi* is stated by Green to have destroyed every box-tree in the Botanic Gardens at Turin in one season.

The Ribbed Tea Mite, *Phytoptus carinatus*, Green, is recorded in Ceylon from Kegalle, Ukuwela, Nuwara Eliya, Haputale,

[* The Barbados form has been described as a distinct species, *T. spinipes*, Hirst (Bull. Ent. Res. iii, 1912, p. 325.)—Ed.]

Peradeniya, Gonakelle, and Passara. A bush badly attacked by this mite has every leaf, except the young flush, of a whitish green or a deep bronze-colour, resembling those of copper beech, the discoloration being more marked on the upper surface. The mites are very minute. Watt and Mann give the distribution of this mite as Assam, Darjeeling, Duars, and Ceylon.

The effect of soil constituents on the immunity of plants to fungus disease :—Some time ago the Mycologist carried out experiments on the effect of manurial applications of sodium chloride and potassium chloride on immunity of the tea plant to Blister Blight. The Blister on the treated areas appeared to be reduced but sufficient data were not obtained to allow of any definite conclusions. In this connection the researches of G. T. Spinks, published in the Journal of Agriculture Science Vol. V part 3, are of great interest. This investigator experimented with the fungus *Erysiphe graminis* (mildew) on wheat and the following statement of the results may be of interest to planters.

> "The conclusions which can at present be drawn from these investigations may be shortly summarised as follows :
>
> Susceptibility to mildew and yellow rust in wheat, and to mildew in barley, is increased by providing the plants with large amounts of available nitrogen : ammonium sulphate and sodium nitrate seem to be equally effective in this direction.
>
> Mineral manures, especially potash salts, on the contrary decrease the susceptibility to disease but cannot counteract the effect of large quantities of nitrogenous manures.
>
> Plants which are semi-starved as regards nitrogen exhibit a considerable degree of immunity, even if the phosphates and potash are also present only in small quantities.
>
> Lithium salts are also effective in producing immunity, while nitrates of lead and zinc, particularly the latter,

render plants extremely susceptible. Other salts of lead and zinc have very little effect on the susceptibility of plants.

A variety of wheat which is almost immune to a disease (such as Little Joss to yellow rust) tends to retain its immunity, even when supplied with excess of nitrogenous food-material.

Increased immunity does not appear to be due to a lack of food-material available for the fungus in the host, as suggested by M. Ward, because the plants rendered relatively immune by adding phosphates or potash to their food-supply were as healthy and well-grown as those receiving no such additions.

It yet remains to be seen what physiological explanation can be found to account for the changes in susceptibility which can be produced in plants by the above means."

Owing to pressure of other work the experiments on tea which were commenced in Darjeeling in 1912 have not been continued but further investigations along the same lines will be carried out when time permits.

Bengal Survey :—An interesting report upon the Topographical Survey of the Khulna district by Major F. C. Hirst, Director of Surveys, Bengal and Assam and 24 Parganas Sundarbans, has recently been published in which the theory is put forward that after Bengal had been formed to a Delta face that extended seawards *at least* from Saugor island to a point just north of Chittagong a local subsidence occurred, which accounts for the present coast line and that afterwards the middle of Bengal was again filled up by the modern alluvium that is now found there. Further investigations on this subject may throw light in the origin of certain soils of the tea districts of which the Red Banks in the Dooars and Tezpur are typical.

Soil Fungi :—Mr. T. J. F. Shaw now Government Mycologist, Madras, has commenced the systematic study of some soil fungi.

The Reserved Forests of Assam:—In a progress report on Forest Administration in the Province of Assam for the year 1912-13 there is an interesting map showing the extent and position of the reserved forests in Assam. This report was printed at the Assam Secretariat Press and is priced at Rupee 1/-.

C. O. P.—1100—6-7-1914.